

A Rough Guide to Interdisciplinarity: Graduate Student Perspectives

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A widely held belief is that only through interdisciplinarity can academics effectively address today's complex ecological problems, because these problems demand cross-disciplinary efforts and specialized knowledge from natural and social scientists. Innovative interdisciplinary research and curricula have been created to train a new generation of scientists to engage with complex issues. It seems critical that those most affected by interdisciplinary education—doctoral students—provide feedback about such innovations. Without understanding students' experiences in interdisciplinary programs, faculty will not know whether they are "getting it right" for future generations of interdisciplinarians. From our experiences as doctoral students, we provide reflections and perspectives on the National Science Foundation-funded Urban Ecology IGERT (Integrative Graduate Education and Research Traineeship) Program at the University of Washington. We discuss the aspects of the program that provided the most beneficial interdisciplinary experiences, as well as those aspects that could be improved. We identify three stages of intellectual development, present questions encountered during each stage, and develop six core recommendations for interdisciplinary research and training programs.

Keywords: IGERT, urban ecology, interdisciplinarity, doctoral education, doctoral student experience

Natural and social scientists addressing complex ecological problems increasingly recognize the value of one another's research, and often seek multidisciplinary, interdisciplinary, or transdisciplinary approaches to investigate real-world issues. A multidisciplinary approach involves researchers from two or more disciplines working collaboratively on a common problem, without modifying disciplinary approaches or developing synthetic conceptual frameworks. An interdisciplinary approach involves the use of an innovative conceptual framework to synthesize and modify two or more disciplinary approaches to deal with a research problem. Finally, a transdisciplinary approach involves nonacademic practitioners working with academics to identify, research, and develop solutions to real-world problems (Tress et al. 2003).

Interdisciplinarity, in particular, is heralded as an educational paradigm that can meet the ecological challenges of the coming century (Palmer et al. 2005). The challenge is to develop collaborative partnerships among researchers to explore the complexity of human–nature interactions (Grimm et al. 2000). Interdisciplinary education exposes students to research in multiple disciplines, trains them in collaborative methods through team research, and promotes new forms of communication and collaboration among disciplines. The goal of interdisciplinary education is to develop new researchers and educators in “science at the leading edge” to effectively address pressing societal and environmental problems (Leshner 2004). Interdisciplinary, and now transdisciplinary, research and training are often part of university mission statements and course curricula, and are explicitly

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Collaboration among researchers in multiple disciplines is the essence of interdisciplinarity. Collaboration entails the collective conception, development, and pursuit of a research problem. Doing this effectively requires time to develop a common language, resolve epistemological differences, and define research expectations. Collaborative initiatives have typically been the realm of established senior scientists (Dubrow and Harris 2006), but now are occurring earlier in academic careers, including undergraduate and graduate education. Recent publications about interdisciplinarity offer synopses of interdisciplinary research and training (IDRT) initiatives, progress reports on interdisciplinary education, and reviews of process-related issues (Ivanitskaya et al. 2002, Sung et al. 2003, Musante 2004, Rhoten and Parker 2004).

Although the current literature explicates some aspects of interdisciplinarity—recognizing cultural and institutional barriers and the need to build community and common language across disciplines, for example (Nicolson et al. 2002, Sung et al. 2003)—it does not explicitly present or discuss PhD students' experiences in IDRT programs. In fact, remarkably little information has been collected or published about the student experience in IDRT programs in traditional university settings. Published perspectives are largely those of IDRT implementers (faculty, established researchers), for whom it is difficult to “understand and empathize with the ways students experience the institution. Faculty and staff tend to see the institution from their own perspective” (Hunt et al. 1992, p. 103). There is little guidance for students considering IDRT programs or for faculty designing them (Pallas 2001, Young 2001, Miller and Brimicombe 2004). In short, the actual experiences of PhD students—perhaps the most well-grounded source of information on the success of IDRT—remain largely unheard, despite the proven utility of investigating students' perspectives to understand other innovative, experimental pedagogy (Anderson et al. 2000). Moreover, the continued success of IDRT depends on the reactions of participating students, who will use their IDRT experiences to decide whether or how to participate in interdisciplinary work in their future careers.

In this article, we provide insight into our experiences as graduate students pursuing interdisciplinary studies and suggest approaches for building long-lasting IDRT programs. We realize that each IDRT program and student experience will be different, but we are confident that our experiences and list of recommendations will be beneficial to individuals developing, implementing, and participating in IDRT programs. We provide our perspectives on the processes, benefits, and challenges of participating in one IDRT program. This rough guide to interdisciplinarity describes how we successfully navigated a natural–social science IDRT program, both individually and as a group. Our objective is to provide our experience within this IDRT context; for an external evaluation of the program, see Heg and colleagues (2004).

We first provide a synopsis of the program (structure, process, and participants). Then we explain the stages by which we progressed through interdisciplinary and disciplinary components of our degrees. We define and describe each stage of progress, concluding each stage with specific questions that we asked. These questions aim to provoke the reader to contemplate IDRT in other settings, taking lessons learned here for application elsewhere. We conclude with six core recommendations to improve doctoral students' experiences with IDRT. These recommendations should be useful for students considering IDRT graduate programs, and for faculty developing them.

Interdisciplinarity, the IGERT way

“We have already too long paid our tribute,” Peter Kropotkin wrote in 1885, “to the mediæval scholastic system of education. It is time to inaugurate a new era of *scientific* education” (Kropotkin 1996, p. 143). Traditional PhD education lacks sufficient mentoring (Nerad and Cerny 1999), overemphasizes research (COSEPUP 1995, Nyquist et al. 1999), and provides limited understanding of the societal consequences of research (Wulff et al. 2004). Many traditional PhD programs do not expose students to differing goals and epistemologies inherent in various disciplines or research agendas. Consequently, PhD students receive only limited training in non-research-related areas to prepare them for careers in academia or elsewhere (Campbell et al. 2005).

Interdisciplinary graduate education aims to resolve these problems by emphasizing collaboration and practical education and research. One example of a national effort to develop a new generation of interdisciplinarians is the NSF-funded IGERT (Integrative Graduate Education and Research Traineeship) program, designed to produce “creative agents for change” during graduate training (Bordogna 2001). Since the program's initiation in 1997, NSF has granted approximately 140 IGERT awards to universities. In 2006–2007, NSF will support 1800 IGERT graduate students. With continued congressional support (NSF 2002) and with universities welcoming innovations in IDRT (Alberti et al. 2003, Musante 2004), support for programs like IGERT will most likely continue at least in the near future.

Our IGERT graduate student experience

In box 1, we present the University of Washington's Urban Ecology IGERT Program (in isolation from our experiences and responsibilities as PhD students) to (a) describe our program's innovations, (b) elucidate issues related to simultaneous participation in an IDRT program and in a traditional PhD program, and (c) bring to the foreground our explanation of the major stages of student development in IDRT. Although some IDRT programs are structured to stand alone, most require students to meet both home department and IDRT program requirements. Students in the Urban Ecology IGERT Program satisfy dual requirements, so we emphasize our experience within this institutional framework.

Box 1. Urban ecology at the University of Washington.

The University of Washington's Urban Ecology IGERT (Integrative Graduate Education and Research Traineeship) Program was developed using the conceptual model described in Alberti and colleagues (2003). The program was initiated by a core group of five faculty from four departments in three colleges. Twenty-five doctoral students in four cohorts participate in the program, representing the disciplines of anthropology, biology, earth sciences, geography, natural resources policy, urban design and planning, and wildlife science.

The core components of the Urban Ecology IGERT Program at the University of Washington include the structural elements in the following table.

Structural element	Goal	Stage	Timeline
Coursework: Introduction to urban ecology	Basic urban ecology, exposure to local and regional urban ecology issues	Naissance	Year 1 of PhD program
Visiting scholar seminar series in urban ecology	Exposure to diverse professionals in urban ecology (academics, politicians, and practitioners), networking opportunities	Naissance, navigation, maturation	Ongoing
Coursework: Advanced urban ecology	Deeper exploration of urban ecology concepts, focus on literature for cohorts to conduct and complete research projects	Navigation	Year 2 of PhD program
Quarterly classroom seminar in urban ecology	Exploration of varied disciplinary and urban ecology literature	Navigation	Year 2 to completion of PhD program
Team research project	Opportunity to learn to conduct team research and to contribute to scholarship in urban ecology by publishing a peer-reviewed paper	Navigation	Begun in year 1, ideally completed by year 2
International visit	Exposure to international urban ecology, to create an international network of urban ecology scholars	Navigation, maturation	One-time trip for each doctoral student in the program, at the end of year 2 or 3
Development and instruction of undergraduate 200-level introduction to urban ecology course	Experience designing and team-teaching undergraduate course in urban ecology	Navigation, maturation	Taught in winter quarter of year 3
Team-authored portion of the PhD dissertation and manuscript for publication	Revision of graduate research and training expectations	Maturation	Timeline depends on individual students' progress

The program's approach to interdisciplinarity is problem based, with the explicit goal of generating scientific research and training scientists to work with pragmatic, policy-related issues. Students work in research teams (three to five people) for their first two years with the goal of producing a publishable paper that reflects critical issues facing urban systems today. The team-authored project is also incorporated into each student's dissertation. The expectation is that the team research reflects an interdisciplinary framing of the research problem, stressing the value of a multiple methodological approach in the research design whenever appropriate. For most students, the team research project occurs before the dissertation proposal is formulated. Past and present teams have completed the research in the following table.

Interdisciplinary research team (start date)	Research project theme	Resulting publication or work in progress
Cohort 1 (2000)	Efficacy of growth management policy tools	Robinson L, Newell JP, Marzluff JM. 2005. Twenty-five years of sprawl in the Seattle region: Growth management responses and implications for conservation. <i>Landscape and Urban Planning</i> 71: 51–72.
Cohort 2 (2001)	Use of scientific information in policies for protecting biological areas	Francis T, Whittaker K, Shandas V, Mills AV, Graybill JK. 2005. Incorporating science into the environmental policy process: A case study from Washington State. <i>Ecology and Society</i> 10: 35.
Cohort 3a (2002)	A century of Seattle park development history	Dooling S, Simon G, Yocom K. From Frederick to Friends: An urban ecological framework for a century of park planning in Seattle. <i>Urban Ecosystems</i> . Forthcoming.
Cohort 3b (2002)	Comparing ecological, social, and economic functions of urban forest spaces	Oleyar MD, Greve AI, Withey JC, Bjorn AM. Evaluating urban forest functionality: An integrated approach. In preparation.
Cohort 4a (2003)	Placement of second homes in relation to natural amenities	Kondo M, Rivera R, Rullman S, Bidwell T. Explaining the physical and social patterns of second homes: An integrated approach. In preparation.
Cohort 4b (2003)	Neighborhood walkability, greenness, and quality of life	Tilt J, Unfried T, Roca B. Relationships among neighborhood greenness, accessible destinations, and health in Seattle, Washington. In review.

Three main stages—naissance, navigation, and maturation—describe our journey in IDRT. Progress through these stages is both linear and iterative as students become interdisciplinary and disciplinary scholars.

Naissance: Where is my home? Early in students' graduate careers, they forge strategic relationships with multiple intellectual communities on campus. While this is also true of other students entering any PhD program, students in the Urban Ecology IGERT Program must develop *dual* intellectual communities, disciplinary and interdisciplinary. Acquaintance with home departments and with the urban ecology program also means developing communities in at least two places on campus (two largely disjunct sets of faculty, degree requirements, and peers). The most active participation in the urban ecology program, in the first two years, occurs during construction of individual doctoral identities, establishment of working relationships in the home departments, and immediate immersion in a group during the first year in the program. Simultaneous involvement in interdisciplinary and disciplinary research and education creates a daunting workload that must be sustained along dual academic tracks.

During the first two years, scholarly initiation is complicated by competing inspirations and expectations. Many students experience difficulty developing individual research pathways as a result of confounding intellectual inputs. Departmental requirements for each discipline are not always aligned with IGERT requirements, and this can impede progress in the interdisciplinary doctoral research teams. For example, requirements for coursework or fieldwork vary by discipline, challenging multidisciplinary teams logistically. First-year students often feel intellectually disoriented working within and between existing institutional structures that are still largely unfamiliar. During this "naissance" stage, students must gain sufficient grounding in various disciplines before identifying links between interdisciplinary and disciplinary identities.

Establishing solid theoretical footing and fulfilling dual programmatic requirements in home departments and in the interdisciplinary program prolongs the naissance period for students in the IGERT program, compared with traditional doctoral students. Disciplinary course loads and immediate immersion into multiple disciplinary epistemologies leads to exhilarated exhaustion. Development of the extended intellectual community of interdisciplinary students and faculty helps students manage this experience. This community is important in each stage, but is particularly crucial in the naissance period for successfully initiating IDRT.

These are some of the questions confronted during naissance: From which scholarly traditions do I draw? Where do I situate my scholarship? How do I develop an academic identity reflecting my disciplinary and interdisciplinary research? What is my identity in my team, and how will we work together? How do I direct my team research and my disciplinary research to obtain maximum benefits from each?

What does an interdisciplinary intellectual "home" mean for my disciplinary work (and vice versa)?

Navigation: What do I prioritize? In the navigation stage, students continue orienting themselves in the home departments and in the interdisciplinary program. They engage in research from increasingly solid intellectual ground and begin to balance disciplinary and interdisciplinary requirements more effectively. They navigate multiple tasks: the responsibilities of team research, individual disciplinary coursework, and other goals or requirements (general exams, dissertation proposals, fieldwork, fellowships, publications).

Navigation is complicated by twofold expectations, intellectual rigor and output, and by dual loyalties to interdisciplinary collaborations and individual (personal, disciplinary) goals. In the navigation stage, students confront difficult issues, including time limitations, individual and team learning styles, and the iterative process of identity formation. Each student, and each group, must develop effective time management skills and clear benchmarks for disciplinary and interdisciplinary academic progress. Identifying these benchmarks requires strategic modes of communication with disciplinary and interdisciplinary faculty to define the role of IDRT for students, and with interdisciplinary team members to establish clearly the expectations of all participants. Navigation often becomes a process of negotiation to define the breadth of research possible and the depth of knowledge necessary to satisfy degree requirements. Successful negotiation is enhanced by strategically choosing committee members who support IDRT (which is sometimes difficult to determine in advance) and who can respond to students' interdisciplinary and disciplinary needs. Traditional graduate education models (i.e., individual PhD research coupled with working as research or teaching assistants) may be as demanding as IDRT, but balancing twofold expectations can mean that commitments to team research must be modified when disciplinary expectations assume priority. At other times, it means accelerating the interdisciplinary research process and delaying disciplinary research. Always, it means communicating and negotiating with faculty and group members.

Questions confronted during navigation include the following: How can I (or do I want to) relate my interdisciplinary and disciplinary work? To what extent does interdisciplinary research help me complete degree requirements? What are the implications of integrating my disciplinary and interdisciplinary research? Will I attain the rigor and depth necessary in my disciplinary research, given the interdisciplinary contribution to my degree? How much research must I do to obtain legitimacy in my discipline and in urban ecology?

Maturation: How do I integrate and represent my scholarship?

This final stage occurs after completing most disciplinary requirements and required participation in the urban ecol-

ogy IGERT. Students complete IGERT team research and identify outlets for publishing results. While completing the IGERT research, they apply for jobs. They demonstrate—in their dissertations and to potential employers—the breadth and depth acquired by simultaneous participation in IDRT and in traditional PhD programs. Given the explicit intent of the program to train a new generation of professionals capable of working within and outside of academia, it is central to students' growth and to the promotion of IDRT that experiences in the program be represented accurately to potential employers. In an academic job search, graduates of IDRT programs can strategically emphasize interdisciplinarity for some jobs and disciplinary for others, as requirements and expectations vary by institution, departments, and disciplines.

To maintain their interdisciplinary identities in new careers, IDRT graduates should investigate prospective institutions' tangible support for interdisciplinarity. Interdisciplinary researchers publish multiauthored articles in journals outside their traditionally defined disciplines. For academic jobs, different institutions' support for teamwork and for single or multiple authorship needs to be assessed. In professional settings, PhDs with interdisciplinary training have already benefited from teamwork training and breadth of knowledge. Graduates of IDRT programs need to know whether employers understand that their qualifications to facilitate or direct teams are beyond the capacity of a typical starting practitioner.

These are questions confronted during maturation: How do I complete and find publication venues for team research? How do I integrate interdisciplinary team research into my dissertation? How do I describe the benefits of participation in IDRT to disciplinarians or nonacademicians? How do I demonstrate disciplinary fluency/proficiency *and* interdisciplinary agility? How do I introduce or promote IDRT in traditional, disciplinary institutions or to nonacademic employers?

Core recommendations

The stages of naissance, navigation, and maturation are distinct but not discrete; they overlap, and each student experiences the iteration differently. However, the stages do represent fundamentally distinct conditions and challenges for IDRT students. Addressing these challenges, we offer six core recommendations to augment the success of IDRT students and faculty among the natural and social sciences and the humanities. Although our program did not include participants from the humanities, we hope and expect that our recommendations will be useful for a wide range of IDRT programs. Our recommendations target professional and personal skills that IDRT participants must be willing to acquire and explore. Both philosophical and pragmatic, these recommendations reflect what works well for us and what could be enhanced.

Core recommendation 1: Attend to the process. This recommendation is simple, yet profoundly difficult to maintain in academia. Attending to the process describes the mental effort necessary to rigorously explore interdisciplinary topics while also addressing the interpersonal dynamics intrinsic in groups. Breakdown of collaboration is a recurrent theme in the literature on interdisciplinarity (Rhoten and Parker 2004). For the authors of this article, instances of constrained collaboration occurred as a result of miscommunication, lack of accountability of team members, or divergent expectations among faculty and students.

To attend to the process, the urban ecology IGERT at the University of Washington hires a professional group dynamics facilitator. This person conducts workshops—attended simultaneously by faculty, students, and staff—on group management skills, interpersonal communication strategies, and creative problem solving. As-needed access to the facilitator helps teams survive and recover from exceptional challenges. We find that this outside facilitation helps minimize and manage disciplinary prejudices and process-related difficulties. Recognizing the need for this “softer” aspect of collaboration contributes significantly to the success of the IDRT program. We recommend incorporating a professional group-process facilitator into any IDRT program.

Core recommendation 2: Develop students' sense of ownership. When students experience ownership of and agency within an IDRT program, a practice of collective responsibility emerges in all program elements (e.g., team projects, seminars, co-instruction). For example, when we facilitate learning in the IDRT group, we each develop unique scholarly identities and areas of expertise. Student ownership and agency are promoted as we design and facilitate a quarterly graduate seminar *ab initio* (faculty are not session leaders), and as each PhD student cohort designs and teaches an undergraduate urban ecology course. Redesigning the seminar quarterly, and the course annually, generates student involvement and camaraderie. While faculty participate in discussions and serve as expert consultants in these program components, students develop and facilitate course themes, structure, and sessions. As a result, students maintain ownership of part of the program, largely guide the exploration of urban ecology, and develop a common language. In addition, we recommend that IDRT programs create opportunities for students to extend ownership and agency by allowing students to coordinate interdisciplinary expert panels and symposia or to develop topical workshops (on geographic information systems or qualitative methods, e.g.) related to specific areas of study.

Core recommendation 3: Garner institutional support. Institutional support is intellectual and financial, and both components are critical for faculty and students. Intellectual support includes the ability to access faculty in multiple departments and to develop PhD committees comprising

multiple disciplines. Engaging in intellectual arenas outside our disciplines as an established *program* on campus enhances our ability to be future leaders of interdisciplinary science, but the challenge for universities is to develop institutional systems of support that sustain the *individual* development of interdisciplinary scholars and that easily accommodate interdisciplinary PhD committees. Doctoral committee members who privilege one epistemological approach over another (e.g., quantitative over qualitative), for example, can cripple PhD student progress and potentially affect retention rates in IDRT programs. In the Urban Ecology IGERT Program, intellectual support is also fostered among students and faculty in workshops, seminars, and collaborations that go beyond IDRT requirements. These activities promote enduring professional networks.

In our IGERT, financial support exists during a portion of the interdisciplinary research and teaching, but not for the tenure of our doctoral education. We must locate additional funding (fellowships, teaching and research assistantships, or outside employment) to finance the last years of the PhD work while fulfilling dual IDRT program and disciplinary requirements. Locating funding is a challenge for all PhD students, but it poses an additional challenge to IDRT students. Our twofold requirements oblige us to conduct two research projects to fulfill degree requirements. The additional burden of teaching or research assistantships overextends students who are already exerting double effort. For example, some students in the program teach two courses simultaneously to satisfy IDRT requirements and remain funded by their home departments (while also completing research). This effectively creates a third commitment, limiting full engagement with or timely progression through the degree. Extending the duration of financial support for IDRT students would ease concerns about finishing double workloads. We recommend that IDRT students approach potential committee members cautiously and ensure that each member supports interdisciplinarity, and that IDRT faculty, from the beginning, conduct and share with students a realistic assessment of potential funding opportunities to support students throughout both interdisciplinary and disciplinary phases of their education.

Core recommendation 4: Plan for your own progress. Graduate students must plan ahead to successfully complete an interdisciplinary doctorate. This planning must be addressed from the outset, individually and within the research group, to integrate departmental (e.g., timely courses, exams, field-work) and team research requirements. Students need to undertake several important steps: (a) clarify the accountability of all team research participants (students, team members, and faculty), (b) align requirements for progress in the home department and the IDRT program, (c) recognize and accommodate the amount of time needed to conduct team research and complete all other requirements, and (d) address individual funding needs before the termination of IDRT funding. By tending to disciplinary work and relationships, students

can help ensure that department chairs and advisors remain aware of their financial needs.

For students, we recommend that you set your own goals, because an IDRT program will neither define your future path nor get you a job. You must identify your route to post-graduate plans. This simple-sounding recommendation cannot be overemphasized. Planning ahead sounds easy, but the reality that participating in IDRT may extend one's graduate experience sinks in only once one is fully immersed in disciplinary research, when timelines for degree completion may already be delayed. Timely success requires your own awareness and planned commitment.

Core recommendation 5: Create and maintain flexibility.

Flexibility regarding logistical issues increases the success of an IDRT program. To remain innovative, programs must maintain flexibility for a diversity of challenges, including short- and long-term structural issues, group dynamics, and variable schedules. For example, different research teams progress at different speeds and encounter different obstacles, and summer research may be impossible for some team members because of competing responsibilities. Effective IDRT programs must treat each student's situation as unique and have the flexibility to accommodate students individually.

Each student cohort experienced the Urban Ecology IGERT Program differently, because some aspects of the program have changed over time. Asking for and implementing students' suggestions to improve an IDRT program encourages self-reflection by students and faculty. Indeed, tangible changes in our program's content and structure were made frequently as a result of formal and informal student feedback. Active involvement within an adaptive model provides collective ownership (by students and faculty) and responsibility for the program's vitality and meaningfulness. We recommend adaptive management for IDRT programs, which allows for feedback regarding pedagogical and research issues and maintains intellectual as well as structural flexibility.

Core recommendation 6: Practice appreciative inquiry.

Understanding and appreciating different worldviews requires a commitment to curiosity about different disciplines' contributions to an interdisciplinary endeavor. Traditional competition among disciplines for recognition, for students, and ultimately for funding limits the productivity and cohesion of IDRT teams, resulting in students' losing perspective about their own goals and expectations. The subtle yet powerful influence of disciplinary biases creates barriers to IDRT (see Lélé and Norgaard 2005). In contrast, an appreciative stance demands that participants ask, "What can I learn from X? How can we help one another?" rather than "What are the flaws in Y? How does it compete with Z?" Appreciative inquiry counteracts academia's culture of cross-disciplinary criticism and calls for patience and diligence in its application. Appreciative inquiry (a) requires participants to reflect on their value judgments when developing research questions and

selecting research methods and (b) cultivates intellectual flexibility. By making conscious efforts to appreciate disciplinary contributions to IDRT, we better understand different intellectual traditions, epistemologies, and methodologies. When IDRT appreciates multiple epistemologies, the space for intellectual curiosity expands.

We recommend an appreciative stance toward all disciplines in an IDRT program, accompanied by the suspension of disciplinary biases regarding “legitimate” research. To implement this recommendation, all program participants must model behavior consistent with disciplinary appreciation. We recommend that participants regularly and explicitly check their perspectives for evidence of disciplinary bias. To practice appreciative inquiry in the Urban Ecology IGERT Program, we developed, posted, and followed “teamwork rules,” such as “Articulate your commitment to operating from a place of curiosity,” “Respect ‘sacred dates’ on group work calendars,” “Respect others’ viewpoints.”

Conclusions

Collaboration among the natural sciences, social sciences, and humanities is critical for addressing current complex issues facing society and the environment. IDRT programs, such as the University of Washington’s Urban Ecology IGERT Program, are innovative approaches that promote experience with and tools for collaboration. As present and former PhD students in this program, we have offered our perspectives on and recommendations for enhancing interdisciplinarity. The processes of defining our intellectual homes, navigating multiple requirements, and meaningfully describing our experiences to future employers are as much a part of our training as are conducting and completing interdisciplinary research projects and disciplinary requirements. The questions we pose highlight important learning opportunities that, when acknowledged and addressed by both students and faculty, promote meaningful IDRT experiences. Our six core recommendations are strategies for creating successful interdisciplinarity, based on what has worked well for us. We offer this rough guide to assist those students who are considering IDRT programs at the PhD level and those faculty members who are designing these programs.

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References cited

- Alberti M, Marzluff JM, Shulenberg E, Bradley G, Ryan C, ZumBrunnen C. 2003. Integrating humans into ecology: Opportunities and challenges for studying urban ecosystems. *BioScience* 53: 1169–1179.
- Anderson SK, MacPhee D, Govan D. 2000. Infusion of multicultural issues in curricula: A student perspective. *Innovative Higher Education* 25: 37–57.
- Bordogna J. 2001. Opening speech. Presented at the National Science Foundation IGERT Meeting; 12 February 2001, Arlington, Virginia.
- Campbell S, Fuller AK, Patrick DAG. 2005. Looking beyond research in doctoral education. *Frontiers in Ecology* 3: 153–160.
- [COSEPUP] Committee on Science, Engineering, and Public Policy. 1995. *Reshaping the Graduate Education of Scientists and Engineers*. Washington (DC): National Academy Press.
- Dubrow G, Harris J. 2006. *Seeding, Supporting, and Sustaining Interdisciplinary Initiatives at the University of Washington: Findings, Recommendations and Strategies*. Seattle (WA): The Graduate School, University of Washington. (13 July 2006; http://grad.washington.edu/Acad/interdisc_network/ID_Docs/Dubrow_Harris_Report.pdf)
- Grimm N, Grove JM, Pickett STA, Redman CL. 2000. Integrated approaches to long-term studies of urban ecological systems. *BioScience* 50: 571–584.
- Heg D, Nerad M, Blumenfeld T. 2004. Innovation in PhD Training: An IGERT at the University of Washington Mid-Term Program Evaluation. (13 July 2006; http://depts.washington.edu/coe/cirge/docs/IGERT_report.doc)
- Hunt JA, Bell LA, Wei W, Ingle G. 1992. Monoculturalism to multiculturalism: Lessons from three public universities. Pages 101–104 in Adams M, ed. *Promoting Diversity in College Classrooms: Innovative Responses for the Curriculum, Faculty, and Institutions*. San Francisco: Jossey-Bass.
- Ivanitskaya L, Clark D, Montgomery G, Primeau R. 2002. Interdisciplinary learning: Process and outcomes. *Innovative Higher Education* 27: 95–111.
- Kropotkin P. 1996. What geography ought to be. Pages 139–154 in Agnew J, Livingstone DN, Rogers A, eds. *Human Geography: An Essential Anthology*. Oxford (United Kingdom): Blackwell.
- Lélé S, Norgaard RB. 2005. Practicing interdisciplinarity. *BioScience* 55: 967–975.
- Leshner A. 2004. Science at the leading edge. *Science* 303: 729.
- Miller N, Brimicombe A. 2004. Mapping research journeys across complex terrain with heavy baggage. *Studies in Continuing Education* 26: 405–417.
- Musante S. 2004. A new approach to combat invasive species: Project-based training for graduate students. *BioScience* 54: 893.
- Nerad M, Cerny J. 1999. Postdoctoral patterns, career advancement, and problems. *Science* 285: 1533–1535.
- Nicolson CR, Starfield AM, Kofinas GP, Kruse JA. 2002. Ten heuristics for interdisciplinary modeling projects. *Ecosystems* 5: 376–384.
- [NSF] National Science Foundation. 2002. Long-Term Ecological Research Program: Twenty-Year Review. (13 July 2006; http://intranet.lternet.edu/archives/documents/reports/20_yr_review)
- Nyquist J, Manning L, Wulff DH. 1999. On the road to becoming a professor: The graduate student experience. *Change: The Magazine of Higher Learning* 31: 18–27.
- Pallas AM. 2001. Preparing education doctoral students for epistemological diversity. *Educational Researcher* 30: 6–11.
- Palmer MA, et al. 2005. Ecological science and sustainability for the 21st century. *Frontiers in Ecology and the Environment* 3: 4–11.
- Rhoten D, Parker A. 2004. Risks and rewards of an interdisciplinary research path. *Science* 306: 2046.
- Sung NS, et al. 2003. Educating future scientists. *Science* 301: 1485.
- Tress B, Tress G, Fry G. 2003. Potential and limitations of interdisciplinary and transdisciplinary landscape studies. Pages 182–191 in Tress B, Tress G, van der Walk A, Fry G, eds. *Interdisciplinary and Transdisciplinary Landscape Studies: Potential and Limitations*. Wageningen (The Netherlands): Delta Program.
- Wulff D, Austin AE, Nyquist JD, Sprague J. 2004. The development of graduate scholars as teaching scholars: A four-year longitudinal study. In Wulff DH, Austin AE, eds. *Paths to the Professoriate: Strategies for Enriching the Preparation of Future Faculty*. San Francisco: Jossey-Bass.
- Young LJ. 2001. Border crossing and other journeys: Re-envisioning the doctoral preparation of education researchers. *Educational Researcher* 30: 3–5.